

STATEMENT OF WORK

FOR

**LANGLEY RESEARCH CENTER (LaRC)
INFORMATION TECHNOLOGY ENHANCED
SERVICES (LITES)**

Exhibit A

DRFP NNL09276610R

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1. INTRODUCTION

The NASA Langley Research Center (LaRC) in Hampton, VA, has been instrumental in contributing to aerospace technology for more than eight decades. Established in 1917 as the first national civil aeronautics laboratory, LaRC has become a comprehensive, world-class center for aeronautics, earth science, space technology, and structures and materials research. Further information on the LaRC mission and its contribution to the NASA vision can be obtained from the web site <http://www.larc.nasa.gov>.

To accomplish its mission, the Center depends heavily on state-of-the-art information technology (IT), embracing computer systems ranging from laptop and desktop personal computers to mid-range computers; network systems ranging from building-dedicated through Center-wide; data storage facilities ranging from CD's to massive, centrally accessed tape storage systems; and all of the associated operating, input/output, data transfer, data management, and data analysis systems.

The Center relies heavily on contractors to provide IT services. Two contracts provide most of the IT services to the Center: The Outsourcing Desktop Initiative for NASA (ODIN) Contract (and its successor I³P contracts, Agency Consolidated End User Services (ACES), NASA Integrated Communications Services (NICS), and NASA Enterprise Data Center (NEDC) for the provision of desktop computing, networking, and telecommunications capability at the Center, and the Langley Information Technology Enhanced Services (LITES) contract to provide services that are not covered by ODIN or the I³P contract. The Research Operations, Maintenance & Engineering (ROME) Contract provides IT services to most of the Center wind tunnels.

In general, the ODIN contract provides a broad range of general-purpose desktop computing support services including system administration, hardware and software maintenance, and help desk assistance. The ODIN approach is designed to offer a comprehensive, end-to-end desktop service for those systems that are considered to be fully functional and mature and provides an operational system that is stable. ODIN will be the default provider of desktop IT services for the majority of LaRC IT systems. The LITES contract, on the other hand, provides computing support services (including system administration and hardware and software maintenance and development of new software applications or modification of existing software to change or add to its functionality) for systems that are either uniquely configured or highly specialized in function and that are not providing office automation services for end users. The LITES services typically involve a wide range of support functions including those for non-standard operating systems, system interfaces, or for use within a dynamic environment such as a research laboratory or test facility. The LITES contract provides system administration as a component of integrated support. Integrated support encompasses all activities necessary to develop, deploy, upgrade, operate, and maintain an IT system which delivers an IT capability.

NASA intends to procure services to provide agency-wide management, integration, and delivery of IT infrastructure services under the Information Technology (IT) Infrastructure Integration Program (I³P) Acquisitions. In line with this strategy, task orders under LITES for the following services will be reevaluated after the I³P contracts are in place:

- Data Center Services (Application/Data Hosting and Housing IT Infrastructure; includes the services and hardware for End-User Devices, Communications, and Data Centers)
- IT Infrastructure Applications (includes those common applications used on a day-to-day basis, primarily for office automation; public website hosting; and web content management and integration)

The I³P contract for Communications Services (LAN, WAN) will not impact LITES since these services are not in the scope of this contract.

2. SCOPE

LITES will include a broad scope of IT services, including new and emerging technologies, that will evolve over the life of the contract. The scope of support to be provided under this contract is intended to cover IT requirements in support of computers, ancillary equipment, software, firmware, services, and related resources.

LITES services fall into the following categories:

- IT Support Services
- Systems and Applications Development Services
- Work Area Specific Services

IT Support Services include, but are not limited to, systems administration, systems maintenance, database administration, and customer support. Section 4 more fully describes the requirements of this category of work.

Systems and Application Development Services embrace new software and modifications to existing software (other than those required for maintenance). Section 5 more fully describes the requirements for this category of work.

Work-Area Specific Services may include some or all of the elements of the scope described in sections 4 and 5, but are specific to particular LaRC work areas that are included in the LITES effort. Section 6 more fully describes the requirements of this category of work.

Work requirements for LITES will be furnished by the Government through the issuance of task orders (TO's). Technical performance standards and metrics will be provided in the TO's and the incentive fee plan.

Software development, operations, and maintenance under LITES apply to software at several levels of risk and control from minimal to critical (as it relates to impact to the Government) that will be specified by the Government in TO's.

The Contractor shall furnish all personnel, training, facilities, specialized equipment not provided by the Government as part of a TO, materials, and transportation necessary to perform these services. For on-site Contractor staff, the Government shall establish an arrangement with the LaRC ODIN contractor and provide all on-site Contractor desktop computers and services for equipment requiring access to the NASA internet protocol (IP) space. Any on-site Contractor-provided equipment connected to the NASA IP space shall require an approved waiver and shall comply with NASA Information Technology Requirement NITR-2830-1, Networks in NASA IP Space or NASA Physical Space.

While the majority of work is directly in support of LaRC at the Center, other Centers within the Agency, other industry and Government partners of LaRC are at times supported. This support may be provided at remote sites.

In the performance of this SOW the Contractor may be required to support IT projects that are subject to the scope of NPR 7120.7, NASA Information Technology and Institutional Infrastructure Program and Project Management Requirements. When such requirements are specified as part of a TO, the Contractor shall comply with NPR 7120.7 as applicable.

The Contractor shall utilize the NASA Langley client-to-network virtual private network (VPN) system to access devices on Internal LaRCNet from the Contractor's offsite facility. Devices connecting to the VPN system must comply with Center and Agency policies regarding VPN access and desktop systems.

3. Electronic Task Order System (ETOS)

The Contractor shall establish, implement, and maintain an electronic task order system (ETOS) for planning, organizing, tracking, and controlling contract and TO activities. The ETOS may be either developed from original Contractor effort or modified from an existing commercial or Government system (e.g., Task Order Management System, TOMS, developed at Goddard Spaceflight Center, or Space Program Integrated Contract Environment (SPICE) Task Order Management System, developed at Johnson Space Center). The Contractor shall automate the work flow process as defined above. The system must meet interoperability standards of NASA-STD-2804, Minimum Interoperability Software Suite, and NASA-STD-2805, Minimum Hardware Configurations. The ETOS shall be compatible with NASA authentication standards and shall meet the requirements set forth in NASA EA-STD-0001, Standard for Integrating Applications into the NASA Access Management, Authentication, and Authorization Infrastructure. This ETOS shall allow for the electronic initiation, routing, review, approval, issuance, funding, and modification of TO's/subtasks. The ETOS shall provide for automatic notification to the approvers of the need for approval. For each TO/subtask, the Contractor shall track estimated cost and fee, funded cost and fee, deliverables, and actual and projected cost through TO completion. The Contractor shall track cumulative contract estimated cost, fee, and funding. The ETOS shall also provide a mechanism to track and assess customer satisfaction regarding quality and timeliness of performance, cost and other TO specific metrics. The ETOS shall allow privileged users' (e.g., COTR, TM, and CO) review of contents of current system. The ETOS data shall be consistent with the data in the monthly progress and financial reports required in Section J, Exhibit C, Contract Documentation Requirements.

At the beginning of the contract the Contractor shall provide to the Government a data schema and data definition table for the application. Any changes throughout the contract performance period to the application will require a new data schema and data definition table. Also, at contract end, or by Government request at any point during the contract performance, the Contractor shall provide to the Government a complete data file containing all task data for the period of performance in a file format compatible with either an Oracle database or standard relational database format. Any portions of ETOS

developed for and paid for by the Government shall be delivered to the Government at contract end.

4. IT SUPPORT SERVICES

Information technology support services are defined at a basic level as applicable to many TO's. The Contractor shall perform any or all of the functions stated in this section for systems that will be specified in TO's. A cross-reference will be provided in the TO indicating what functions of Section 4 will be required for each system in the inventory of equipment and software.

Changes to Agency or Center IT policy will occur throughout the contract period. In all cases, implementation of these policy changes by the contractor shall be mandatory. The Langley OCIO shall be the sole arbiter in any instance where a TM requests a waiver from policy implementation.

Services will be provided for a prime shift of 8 hours per day beginning no earlier than 7:00 a.m., Monday through Friday, except for Federal holidays and other days when the Center is closed. Flexible shifts are permitted when the TM concurs that the requirements of the task can still be met. Where more rigorous requirements exist, they will be defined in TO's.

The contractor shall monitor the currency of maintenance contracts and software licenses and notify the TM at least 6 months prior to the expiration of the maintenance contract or license. In some cases, the contractor will be responsible for acquiring the licenses. All supported software will be licensed to the Government.

4.1. System Management/Administration

System management and system administration are interrelated and yet distinct activities. System management pertains to policy and procedures and applies to all TO's. System administration is more the hands-on operation, support, and maintenance of system hardware, software, and peripherals. The contractor shall perform any or all of the following requirements as directed in TOs:

4.1.1. Configuration Management

Maintain a configuration management process that will meet the systems' security plan and NIST guidelines. Document and keep current standard configurations and processes, as well as any deviations to those standards, for all systems related to the TO.

4.1.2. System Software and Hardware Upgrades/Enhancements

- a) Monitor user requirements and system performance. Monitor the availability of updates and upgrades to installed equipment and system software and the availability of new equipment and system software that would apply to the supported system. Participate in system reviews and recommend the installation of updates, upgrades, and new equipment and system software as appropriate. All systems shall be upgraded as new versions or updates are made available such that they are compliant with NASA-STD-2804.
- b) Plan for the installation of new or upgraded equipment and system software. This includes the consideration of cost, schedule, performance, power, environmental utilities, space limitations, networking, workflow, and the impact on other elements and

users of the system. The Contractor shall include a set of reviews and written test procedures in accordance with industry best practices and Agency and Center IT policy.

- c) Following Government approval and successful completion of all testing and reviews, install and verify the operability of new or upgraded equipment and system software. Minimize unavailability of system services.
- d) Recommend specific solutions and obtain quotes from appropriate suppliers.
- e) Maintain a realtime list of system users, including business and scientific application points of contact. Inform all users of impacts from system upgrades and improvements a minimum of 2 weeks prior to any upgrades or system outages.

4.1.3. Operations

- a) Perform routine operations such as power up and shut down.
- b) Interface with equipment vendors or service providers for the maintenance of equipment and software.
- c) Interface with network service providers for access to networks and to resolve problems associated with network access. All network connections shall follow Agency and local policy and guidance.
- d) Diagnose anomalies in the operation of equipment or system software. Provide timely fixes or work-arounds where possible. Report and document problems requiring correction. When necessary, interface with other IT service providers to resolve problems. Initiate corrective action. Follow up to ensure problem resolution. Response to problems during prime shift will be within 2 hours of notification or as specified in TO's. Ensure all changes and resolutions are documented.
- e) Backup and restore files to ensure reliability of files. Create a backup plan, contingency plan and test procedures to be tested annually. Monitor the operation of the system and adjust the configuration and system parameters as necessary to maximize operational efficiency.
- f) Create and modify scripts that increase functionality or enhance system operation or performance and document.
- g) Recommend operational improvements and implement them upon Government approval.

4.1.4. Documentation

Develop, deliver, and maintain the following documentation:

- Baseline hardware and/or software configuration.
- Backup/Recovery procedures and test procedures.
- Access control procedures and authorization records.

Additional documentation may be defined in TO's.

4.2. Hardware Maintenance

Hardware maintenance as defined in this section includes the repair and replacement of hardware components necessary to ensure operability of the covered equipment or to return the covered equipment to a fully operational status. The covered equipment includes those items that are specifically identified in a TO. Services that shall be provided in satisfying the hardware maintenance requirements include:

- a) Diagnose problem or failure.
- b) Repair or replace failing components. Replacement parts shall meet or exceed Original Equipment Manufacturer's standards.
- c) Verify and document that repair or replacement performs to manufacturer's standards.
- d) Verify and document that the performance of the system following the repair or replacement of failing components, meets or exceeds the performance of the system prior to system failure.
- e) Reload any files and/or data (if accessible) that are contained on a replaced or failing component before returning the system to operational status.
- f) Return any replaced components that contain classified data to the user.
- g) Based on current Agency guidelines and IT Security policy, cleanse (to ensure that data is fully erased and not retrievable or accessible by any means) any replaced data storage equipment that contains unclassified data prior to disposal or returning to the supplier, and maintain a documented log to indicate that this action was completed.

4.3. System Software Maintenance

System software maintenance as defined in this section includes the services required to ensure continuing operation of system software. All supported systems software will be licensed to the Government and will be specifically identified in a TO. The contractor shall perform any or all of the following requirements as directed in TO's.

- a) Analyze software failure or performance degradation.
- b) Obtain software updates and upgrades from the vendor or public domain sources (if required in individual TO's).
- c) Install software updates to ensure that system is operating at the current IT Security posture.
- d) Verify system operation following software upgrades.
- e) Perform full system, file, and data backup prior to software upgrades.
- f) Preserve and/or restore all files and data during software upgrades.
- g) Ensure that any and all Agency required software is loaded and maintained, (i.e., Patch Management client software, etc.) if applicable to meet Agency guidance and policy.

4.4. Application Management

Application management is highly integrated with the management of system software, servers, associated system hardware, and overall system administration operations. Consistent proactive monitoring, system design, and tuning assure optimal resource utilization and performance.

The application software used in support of NASA LaRC missions, business processes, and specific IT functions range from high end commercial suites to open source packages to locally developed applications and specialized NASA applications, processes and tools which are integrated across commercial and open source architectures into cohesive computing environments.

These applications (with representative examples) can be categorized as follows:

- 1) Agency Systems, e.g.:
 - a. Integrated Enterprise Management (IEM) software for core business management and administrative functions such as
 - SAP, Business Warehouse (BW) Reporting Tool, WebTADS, Agency Labor Distribution System (ALDS), Federal Personnel Payroll System (FPPS), Contract Management Module (CMM), and P-Card
 - b. E-gov initiatives; FedTraveler; Workforce Integrated Management System (WIMS)
- 2) COTS software, including for example—
 - a. Pro/Engineer Computer Aided Design package.
 - b. NASTRAN, PATRAN, Matlab, or similar engineering analysis software.
- 3) Non-COTS (non-Agency) software not developed locally, including for example—
 - a. Funds Control System (FCS)
- 4) Software developed by or for LaRC and used in production mode, including for example—
 - a. Airspace and Traffic Operations Simulation (ATOS)
 - b. AeroCompass data reduction software for processing wind tunnel test data and flight data.
 - c. FAB Work Order Control System (FWOCS)
 - d. Programmatic Budget Development (PT)/Planning, Programming, Budgeting and Execution (PPBE) Tools, e.g., Center Management & Operations Budget Tool (CMOBFT) automates the gathering of the CMO budget details, shortfall requirements, and reduction scenarios by Project/organization; Langley Integrated Financial Environment (LIFE); Cost Analysis and Reporting Tool (CART); LaRC Financial Dashboards.

e. User Profile / Training Request System

Application services may be required as part of integrated support as described in Section 1, Introduction, or it can be an independent requirement. In the case of an independent requirement, the Contractor shall interface with other cognizant IT personnel to plan upgrades and resolve problems. Application management requirements include:

4.4.1. Application Maintenance, Upgrade, and Improvement

- a) Develop and maintain a configuration management process (consistent with section 4.1.1) to include the following:
 - Current software versions
 - Status of planned upgrades
 - License information
 - Software maintenance status
 - Locations of source code and documentation
 - Issue/bug tracking
- b) Optimize the execution of the application. Monitor the application for anomalies and respond to customer trouble reports. Analyze problems, interface with cognizant IT personnel if necessary to resolve problems. Implement and record corrective action.
- c) Plan for and recommend evolution of the application. For example, advise the Government on applicability of upgrades and recommend possible software solutions to identified user requirements.
- d) For COTS and non-locally developed applications, actively monitor availability of patches and upgrades. Evaluate upgrades, recommend schedule for upgrade, and inform customers of impact of upgrade.
- e) Interface with software vendors to obtain patches and upgrades. Procure software updates and upgrades from the vendor (if required in individual TO's). Install patches as required to ensure that application remains current, secure, and reliable. Install upgrades according to schedule approved by the Government. Interface with cognizant IT personnel as necessary to ensure smooth upgrade. Perform upgrades with minimal impact to users and notify users of interruptions in application availability.
- f) Maintain software developed by or for LaRC. The Contractor shall document and execute a maintenance plan that complies with the requirements of NPR 7150.2, NASA Software Engineering Requirements. The process shall be tailored to the particular software package and applied with a rigor consistent with the software class. Maintenance process requirements by software class will be further defined in a TO to be issued at contract start.
- g) Advise customers on effective use of the software.
- h) Analyze the agency IT security policies in order to implement these security measures for unique hardware and software needed to accomplish mission requirements and be in compliance with Agency and Government policies and mandates.

- i) Ensure all applications are tested using a commercial testing tool for IT Security related security vulnerabilities prior to going into production as well as regularly throughout the application life cycle.
- j) Work with local IT Security team and system owners to ensure that all proper safeguards have been implemented and documented in the IT Security plan for the system housing the application.

4.4.2. Documentation

- a) For COTS and non-locally developed software, maintain and make available a library of application documentation via a web-based library.
- b) For software developed by or for LaRC as identified under Subsection 4.4.1 (f), deliver a Configuration Management Plan within two weeks of receiving the TO. The Configuration Management Plan shall document the level of maintenance to be performed; how problems and/or modifications are identified, classified, prioritized, tracked, and analyzed; and the approval, implementation, and test process to be used.

4.5. Database Administration

Database administration (DBA) shall be provided for those TO's identifying a database management system (DBMS) environment, including DBMS software and associated database tools. The contractor shall perform any or all of the following requirements as directed in TO's:

4.5.1. Installation of Database Software and Tools

- a) Utilize the Center's Central Web and Database Servers as the default condition. Provide written justification when the requirements prohibit the use of the central services.
- b) Install and maintain new and upgraded DBMS software and associated tools on both production and development systems. Identify impacts of new and upgraded software by testing, documenting, and communicating impacts to customers, IT Security, network services, and the Center IT Operations Board before implementation.
- c) Install and maintain new and upgraded databases on both production and development environments.
- d) Ensure operability of the DBMS environment. Achieve and document a common or standard configuration for the DBMS environment to enable application developers to efficiently produce predictable results.
- e) Ensure compatibility between the DBMS and the operating system and interact with cognizant IT personnel to ensure that the system adequately supports database applications.

4.5.2. Monitoring and Configuring Database Engine and Tools

- a) Monitor activity of the database engine to determine efficiency of the database engine and applications. Manage disk space allocations, perform consistency checking, and monitor logical/recovery logs as well as notify the Government and/or network services provider of any impact to the network or related services.

- b) Based on the configuration of the file server and the existing and projected database workload, configure the database engine to optimize performance of database applications while minimizing effects on the rest of the file-server workload.
- c) Analyze the database workload and storage needs and plan for growth for databases and applications. Make determinations of DBMS software to support these needs, and communicate hardware/system software requirements to system administrator. Implement recommendations upon Government approval.
- d) Monitor use of the licenses for the database engines and related tools and provide report to Government. Communicate with vendors and the Government to develop software maintenance strategies and maintain current licenses. If the database is an Oracle database, all licenses must be coordinated with the OCIO through the Agency License Management representative.
- e) Provide solutions for allowing connections to the database engines from other platforms while following appropriate IT Security concerns. These solutions will include the use of ODBC (open database connectivity) and database client tools. Provide user training in the installation and configuration of these connections as needed.
- f) Ensure that all updates and patches are current in accordance with the Agency guidance and IT Security

4.5.3. Archiving and Restoring

- a) Archive and restore the database instance and logical logs, and provide input into system disaster/recovery plan to ensure restoration of database. Restore data as required.
- b) Create a test plan and perform periodic tests (at least every 6 months) to ensure that hardware, software, and processes will function as required to support archiving and restoring of data and to verify the disaster/recovery plan. Document all results appropriately.

4.5.4. Security of databases and instances

- a) Maintain security of databases by managing access and passwords in compliance with NPR 2810.1A and DBMS application-specific requirements.
- b) Assist developers with managing access privileges to tables, stored procedures and other areas of the database.
- c) Periodically (at least weekly) audit logs to identify potential security breaches. Notify IT Security of any and all suspected inappropriate activity.

4.5.5. Documentation

Fully document, deliver, and maintain documentation for the following:

- Current configuration of the database environment including site specific parameters and tools installed and their availability.
- Historical tracking of changes made to the DBMS environment over time.
- Operational procedures in the administration of the database environment
- Procedures to be used by end users using the database environment

- Database archive/restore strategy to be included in system disaster recovery plan

4.5.6. Resolution of Problems/Issues

- a) Provide troubleshooting to identify and solve problems/issues related to the database instance or related tools. Document these problems/issues and lessons.
- b) Interface with system administrator and application developers to develop solutions to problems and implement corrective action. Maintain trouble report tracking system to give status of problems and their resolution.

4.6. Customer Support

I³P will provide **Tier 1** help desk support for the Center. The LITES contractor shall establish a signed formal agreement with the I³P contractor to coordinate assignment, tracking, and resolution of I³P help desk calls pertaining to systems and applications supported by LITES.

A basic level of customer support is required for all IT Support Services to include:

- a) Consultation and assistance on basic use of equipment and applications.
- b) Efficient mechanism for communication between customer and IT support staff.
- c) Prompt response (within 2 hours) to user problems. Two hours commences when the call is received by the LITES contractor.
- d) Provide and use an electronic customer request tracking system to give the current status of requests or problems and their resolution.
- e) Interface with system administrators, system security administrators, database administrators, and other application administrators as necessary to resolve the problem for the customer.

Other customer support activities such as help desk, training, and end-user documentation will be specified in TO's.

4.7. Consultation and Training

The Contractor shall provide technical support, consulting, and coordination to ensure orderly system implementation, integration, and operation of all systems, systems software, and application software identified in TO's. The contractor shall perform any or all of the following requirements as directed in TO's:

- a) Assist the Government in defining data and information requirements, data sources, and intended end-user applications, and recommend appropriate information technology, products, and capabilities for satisfying information requirements.
- b) Design, develop, and revise training materials for systems and applications relevant to LITES Contract. Schedule classes, arrange logistics for classes, conduct training, validate training effectiveness, and provide information for input to student records.
- c) Perform studies analyzing new technologies, analyzing feasibility of technical approaches, defining user requirements, analyzing existing environments, identifying constraints, deriving and analyzing alternative solutions, recommending approaches and solutions, and estimating costs and benefits.

- d) Advise on internal programs/projects which require financial information access and delivery solutions.
- e) Partner with LaRC to deliver new solutions and capabilities.
- f) Participate in cross-business initiatives that deliver analytical solutions and define the next generation of financial analytics.
- g) Perform ad-hoc system/user issue resolution.

5. SYSTEM AND APPLICATION DEVELOPMENT SERVICES

Services in this category involve the development of new software or the modification of existing software to change or add to its functionality. Modifications to correct faults, improve performance or other attributes, or to adapt to a changed environment, are considered maintenance and are covered in Section 4 of this SOW. The contractor shall perform any or all of the following requirements as directed in TO's:

- a) Design and development of new software packages to meet specified requirements.
- b) Design, development, and/or integration of new systems integrated from hardware, commercial software, and newly developed applications.
- c) Development and integration of software applications within existing system environments; for example, a database application developed on central database servers.
- d) Modifications to existing software to change or add to its functionality.
- e) Software support to research and/or development projects that involve the continuing evolution of specialized algorithms and techniques.

5.1. Work Requirements

In the planning and execution of the work as specified in the TO, the Contractor shall undertake any or all of the following activities:

- a) Analyze requirements to determine the feasibility of providing the desired software, target computer system, computer programs, results, documentation or other deliverables.
- b) Document the conditions and capabilities that must be met or possessed by the product (the design to requirements).
- c) Integrate equipment, software, communications, and processes to develop and deploy a new system or IT capability, including procurement of hardware and software if required.
- d) Design, develop, and test software to meet specified technical and quality requirements.
- e) Modify existing software in order to change or add to its functionality.
- f) Perform authentication of application configuration against documented user requirements. Provide systematic control of application software change requests.
- g) Perform software quality assurance, prepare test plans, perform software acceptance testing, and document test results.

- h) Prepare installation and operations plans/procedures to support systems or applications delivery.
- i) Develop or update documentation such as user manuals, reference manuals, requirements documents, design documents, and test plans using either online or hard copy format. Maintain configuration of the documents within the LaRC Document Management System.
- j) Perform independent analysis of mathematical, logical, system approaches and perform comparison studies of competing techniques to solve problems.
- k) Collect and analyze process and product metrics. Identify, evaluate, and implement promising new processes, procedures, and technologies to improve software engineering capability, productivity, and quality.
- l) Comply with the requirements of NPR 7150.2, NASA Software Engineering Requirements, augmented by software-related Langley Management System Center Procedures; NASA-STD-8739.8: Software Assurance Standard; and NASA-STD-8719.13B: Software Safety Standard. Processes shall be tailored to the specific project and applied with a rigor consistent with the software class and safety criticality. Life-cycle process requirements by software class will be further defined in a TO to be issued at contract start.
- m) Certain TO's may involve software development for human-rated software systems, non-human space rated software systems, or mission support software that would require the Contractor to be rated at Capability Maturity Model – Integration (CMMI®) for Development Capability Level 2 or higher.

5.2. Software Engineering Process Support Requirements

The Contractor shall provide software engineering support, including the definition, implementation, and continuous improvement of complete software development lifecycle processes and procedures for LaRC as a whole, individual LaRC organizations, and projects. The primary focus of this area is to support LaRC organizations with implementing LaRC's Software Process Improvement Initiative, the software-related Langley Management System Center Procedures, NASA software related NPRs and standards, and the process areas of the Software Engineering Institute's Capability Maturity Model–Integration (CMMI®).

5.3. Information Systems Development

The Center is continuing to develop the LaRC Business Application Information Architecture, that is, a framework within which business information management systems shall be designed. No database development shall be performed in legacy database application environments, and any modifications to legacy databases shall include conversion to the LaRC business application information architecture. The architecture relies on standards and configuration control to provide interoperability between databases, reduce the development of unique or duplicative systems, permit focus and skill-building among the technical and consumer work force, and reduce application specific training required by end users.

The Business Application Information Architecture technical environment consists of a suite of tools and database management systems which support the standards selected for use. Current tools include:

- Operating Systems
 - Solaris
 - Linux
 - Windows
- Web Server
 - Apache
 - I-Planet
- Database Management
 - Oracle
 - MySQL
- Reporting Tools
 - Hyperion tools
 - Business Objects Crystal Xcelsious
- Open Source Scripting Code
 - Perl
 - PHP
 - .NET

Research oriented tasks may not use the standard architecture as described. Exceptions to the standard architecture will be specified in the TO and will have requirements that would not allow it to be housed in the Center's Central Web and Database environment.

5.4. Data Reduction Programming and Analysis

The Contractor shall provide data reduction programming and analysis support to a wide variety of research facilities with research disciplines ranging from rotorcraft, low-speed aircraft to hypersonic spacecraft, dynamic flight testing, and structural analysis and materials research in static laboratory testing. A significant portion of this support includes the development of utility and application interfaces such as Graphical User Interfaces (GUI) code or control software, using COTS packages. The development may also include data acquisition software and translators for information exchange between heterogeneous platforms and other IT intensive applications. The extent of the application management support for the existing and newly developed applications may range from installation only to full support involving additional software or script development, code enhancements, execution of the application, generation of required products, and consultation.

6. WORK-AREA SPECIFIC SERVICES

The work areas of the LaRC IT environment described in this section represent some, but not all, of the support required throughout the life of the contract.

As stated in Section 3, TO's will be issued to specify required services. These services may include any or all of the general support requirements given in Section 4 and software development requirements given in Section 5, but also may include requirements that are specific to a work area. In addition to a brief description of each work area, specific requirements are listed that are representative but not all-inclusive of that work area.

Reference to "integrated support" of a system or systems encompasses all activities necessary to develop, deploy, upgrade, operate, and maintain a production IT capability.

Many of these work areas require services involving the operation of hardware and software systems to produce data; reports; or business, scientific, or engineering solutions. If this is the case a TO will require that the Contractor develop an "Operations Plan," defining the procedures for receiving requests; prioritizing, approving, scheduling, and executing work, and delivering products; resolving operational problems; providing user assistance and training.

6.1. Centralized Web and Database Servers

The Central Web and Database Servers are designed to meet the general server computing needs of the Center. The servers are provided by the OCIO as a way to more efficiently, effectively, and securely meet the needs of the Center. The OCIO provides these services to the NASA Langley Research Center users and other NASA center users. The environment used to support these services consists of a heterogeneous network of Unix, Linux, and Windows. Onsite system administration is required to maintain resource availability and IT security within and outside the LaRC domain. Central web servers and products on those servers are available for web site hosting and web development activities that promote and support LaRC teams, organizations, and programs. Several web technology products are available on the centralized web servers including web server software, web application development software, a search engine, site usage analysis tools, and Secure Socket Layer (SSL) capability. Requirements specific to this work area include:

- Provide integrated support for central web servers including system administration, performance and security monitoring, daily backup, log monitoring and archival, and monthly access reports.
- Provide for all hosted web sites a unique virtual server name, a dedicated IP address, disk space for site development, and monthly report of site activity.
- Respond to problems and questions directly related to web software residing on the central servers and monitor sites and servers for any problems that interrupt services or compromise security. Collaborate with the network services team as well as the IT Security team to ensure all requirements are met and that no adverse impact to the network is experienced.

The environment generally consists of the following:

Operating Systems:

- Windows
- Linux
- Solaris

Web Servers:

- Apache
- I-Planet

Databases:

- Oracle
- MySQL

Scripting Language Support:

- PHP
- Perl
- .NET

Search Capabilities:

- Google Search Appliance

Web Usage Statistics:

- WebTrends

Other applications and user tools that assist in the operation and maintenance of the environment are also used. The contractor (in collaboration with the government) shall introduce new tools into the environment as technology evolves.

6.2. LaRC Digital Library Systems

The OCIO provides desktop electronic information services to NASA Langley Research Center users and other NASA center users. The OCIO operates a number of integrated hardware-software systems consisting of commercial-off-the-shelf (COTS) applications, LaRC developed applications and commercial information products. These products and applications are used to provide Center-wide information systems and services to the LaRC and NASA technical community in accessing information related to engineering and research and to address overall information management needs. These systems include: (1) Langley Digital Repository using DSpace that has more than 70,000 unique aerospace digital documents with navigation and search capability; (2) Technical publications approval and management system (TPSAS) that is required to be used by all Langley authors and publications; (3) Google search system that integrates internal and external databases, subscriptions, and web sites providing easy access to technical information; (4) electronic materials request system such as ILLIAD; (5) NASA GALAXIE, a NASA-wide on-line library management system providing modules for managing circulation, acquisitions, cataloging, and serials; (6) Federated search tools such as Metalib and SFX; and (7) Bibliographic information management tools such as Refworks. New digital and electronic information products are emerging rapidly, and the OCIO is continuously evaluating and planning to incorporate these new products to maximize the use of content, address information overload and to enhance the services.

Services shall include application configuration, application management, database administration, customer support, and IT consultation and training to the OCIO staff in order to support the users. Requirements specific to this work area include:

- Provide application configuration, application management, application development and customer support for the Langley Digital Repository system that uses DSpace software.
- Provide application management, and customer support for Langley Google system that uses Google Search Appliance and Google Custom Business Edition software.
- Provide integrated support for NASA GALAXIE system and provide customer support to staff in all NASA libraries in the form of telephone support, staff training, and documentation.
- Provide integrated support for all other systems: TPSAS; RefWorks; SFX; Meta-Lib. Install, update, configure, maintain, and provide customer support.
- Operate, maintain, and enhance digital library applications; Perform database administration and maintain and enhance database applications.
- Provide usage statistics and trends and inputs as to maintenance needs of the various systems, needed system upgrades, changes in system technology, and new digital information products and services that can help the user community.

6.3. Database Administration and Management

A central database architecture is part of the Central Web and Database Servers available for the development of applications by LaRC teams, organizations, and programs. The central environment can be used to develop applications to be hosted on central database servers or on customers' own systems. The Contractor is responsible for providing and managing software, tools and administration of database systems and for supporting NASA and the NASA Langley Research Center (LaRC) community requirements and initiatives. The contractor shall provide support in the following areas:

- Provide integrated support for central database servers including database administration of Oracle and MySQL.
- Administer Oracle and MySQL licenses and licenses for associated database development tools. License management is provided by the Government.

6.4. Large Scale Data Storage and Retrieval System

The Contractor shall support the Central Storage System (CSS). The CSS provides large scale, network-accessible storage for LaRC, other NASA Centers, and their approved contractors. CSS uses a Hierarchical Storage Management (HSM) approach with three levels in its storage hierarchies:

- Disk
- Primary copy tape
- Secondary tape

The current configuration consists of IBM AIX servers, Fibre-Channel disk array systems, and a Sun/StorageTek Automated Cartridge System with T10000A and T10000B tape technologies. The HSM software used is IBM's High Performance Storage System (HPSS). The CSS is used by users at LaRC and other NASA centers to store:

- Archive data (for both active and non-active projects)
- Working File Sets (Temporary storage of large data files for near-term computational needs)
- LaRC Distributed System Backup Data

Requirements specific to this work area include providing quality round-the-clock data storage and retrieval services to individual users and IT services. The Contractor shall ensure the security of the stored data by maintaining highly disciplined control and monitoring of the physical and software accesses of data as well as the environmental factors required of the tape technologies for data integrity. The Contractor shall ensure user-transparent migration of data prompted by hardware and software technology upgrades. Additionally, the Contractor shall address new user or project data requirements and Government's IT infrastructure requirements, and evaluate mass storage systems and technologies and the interface of mass storage systems to other IT technologies. The Contractor shall develop maintenance contracts for all CSS hardware and system software with the exception of HPSS support, which is provided by the Government. The Contractor shall provide the offsite storage services. The Contractor shall provide for disaster recovery of data for CSS by housing the Secondary Copy Tape offsite in a secure facility.

6.5. LaRC IT Security Manager Support

The Contractor shall support the LaRC Information Technology (IT) Security Manager (ITSM) or Designee to implement the IT Security (ITS) Program at LaRC in accordance with NIST guidelines and NPR 2810.1x, Security of Information Technology (see the following URL: <http://nodis.hq.nasa.gov>). The ITSM's role is to develop Center-wide IT security policies and guidance, to provide computer awareness and training, to maintain an incident response capability, and to document, review, and report the status of the Center IT Security Program. The Contractor shall provide NASA Langley Research Center with the following: incident response and computer forensics; intrusion detection and monitoring; remote access compliance; consultation for ITS planning; coordination of ITS activities with other Centers and the Agency Security Operations Center (SOC); perimeter protection, to include support and operation of a Virtual Private Network (VPN) and firewall; and outreach. They shall also provide system administration support for the systems that support the ITSM's role, including the Langley Registration Authority (RA) for the NASA LaRC Public Key Infrastructure (PKI) at NASA LaRC.

6.6. Geometry Modeling and Grid Generation

Geometry modeling and grid generation support includes the production of accurate geometry definitions and numerical grids for Computational Fluid Dynamics (CFD), Computational Structural Mechanics (CSM), and other engineering analyses. This work is centered in the Geometry Laboratory (GEOLAB). Requirements specific to this work area include:

- Provide integrated support for the GEOLAB systems.

- Create and modify numerical geometry models using computer aided design software systems to be compatible with software tools using multi-block structured or unstructured grid generation techniques.
- Generate numerical grids compatible with the physical conditions to be investigated and the software and geometry configurations used for analyses.
- Analyze grid quality and validate the integrity of geometry models and grids.
- Incorporate geometry model measurements acquired using digital scanners into geometry models.
- Develop software and interfaces to integrate use of geometry tools within analysis and visualization tools.
- Provide consultation services in structured and unstructured grid generation and geometry modeling techniques.

6.7. Data Visualization and Image Processing

Data visualization support involves the development and application of data analysis and visualization tools and techniques for a wide variety of disciplines including Computational Fluid Dynamics, Computational Structures, atmospheric modeling, remote sensing, and experimental fluid dynamics. This work includes support of the Data Visualization and Analysis Laboratory (DVAL). Requirements specific to this work area include:

- Generate static and dynamic visualizations from experimental and computational data sets.
- Process and analyze large sequences of video images.
- Apply collaborative virtual environments technology to specific research problems.
- Develop custom software applications with sophisticated graphical user interfaces.
- Apply feature extraction techniques to complex, multivariate data sets.
- Consult on methods for the comparative visualization of simulated and observed results.

6.8. World Wide Web Application Development and Support

WWW support is focused on application development activities at LaRC. The term "WWW application" refers to software products that include a World Wide Web browser as their user interface. Typical WWW applications are comprised of static or dynamically generated code in Hypertext Markup Language (HTML) or a scripting language, often include executable components and sometimes include connectivity to databases. Requirements specific to this work area include:

- Develop WWW applications including web page interface design.
- Develop code and data reuse repositories.
- Keep current with latest web technologies and architectures, and recommend ways to use these technologies at LaRC.

6.9. High Performance Computing and Distributed Systems

LaRC is currently involved in many high performance computing programs and projects. The systems that these activities require are current, state-of-the-art computing systems that utilize a variety of computer hardware, operating systems (e.g., Linux, MacOSX, and/or Windows), and applications codes. The major requirements for the support of high performance computing specific to this work area include:

- Provide expert consulting services on the application of high performance hardware and software solutions for Langley's programs and projects.
- Administer organizational level and center level computer systems used primarily for the production of engineering data where large numbers of processors, large memories, or extensive data management is required to meet LaRC engineering and scientific goals.
- Facilitate the development, debugging, performance analysis, and optimization of user and system wide applications.
- Develop performance metrics, benchmark, test, and evaluate new architectures and software to meet current and future needs.
- Administer LaRC parallel and clustered computational, visualization, or application servers including state-of-the-art architectures.
- Support specialized libraries for system or software development for high performance computing architecture.
- Support compilers, development tools, and specialized applications codes for use on high performance computing architecture.
- Develop unique solutions to isolate, eliminate or mitigate information technology centric problems in engineering and scientific applications.
- Provide expert consultation in the design of state-of-the-art computing systems including clusters, file servers, parallel and high performance file systems, visualization, and cluster interconnection and software for these systems.

In addition to the high performance computing requirements there are distributed systems consisting of clusters of networked computers and associated equipment, located at various sites throughout the Center, which are used in specific experimental or analytical environments. These clusters are generally used by small groups of researchers or engineers with particular specialties such as computational fluid dynamics, computational structures, engineering design and development, modeling and simulation, software development, and other IT intensive applications. Most work will be accomplished at LaRC; however, occasional travel will be required to support work in collaboration with other NASA centers, Government agencies, and industry.

The services required for distributed systems primarily consist of systems administration, database administration, hardware and software maintenance, and applications management as described in Section 4. Applications programs include "Commercial-off-the Shelf" (COTS) as well as custom software developed by civil service personnel or other contractors. Support for this application software may include only the distribution and installation of the applications package and upgrades (designated as software mainten-

ance) or full technical support services including software development, enhancements, and consultation. Some examples of COTS applications support requirements include support for Pro Engineer, Windchill, Matlab, LabView, NASTRAN, and Mechanica as well as locally generated software for engineering analysis, database management and knowledge management.

6.10. Geographic Information Systems

Geographic Information System (GIS) is an intuitive spatial data management and decision support tool. Institutional managers are the current primary users of data and processes, but use of the technology by researchers is on the rise. The spatial information management system is built around a relational database consisting of data that includes or is derived from such records as: aerial photographs, topographic maps, descriptions and engineering drawings of buildings and facilities, utility plats, geological data, climatic records, financial data, and personnel locator records. The location of objects such as buildings - or even individual offices - is given with high accuracy in coordinates derived from the satellite-based Global Positioning System (GPS). GIS at LaRC strives to integrate functions such as Master Plan, Real Property, Space Utilization, Facility Maintenance and Operations to increase accuracy and sustainability of data. Support is often provided at remote sites.

The database can be interactively queried through web pages to extract up-to-date maps or plans restricted to selected features or to produce reports relating selected data. Examples are: maps depicting the effects of flooding correlated to tidal stages; maps and reports detailing utility systems; maps and reports in support of master planning (e.g. land use, security, emergency evacuation, traffic flow, parking, landscaping and environmental monitoring); and reports on space utilization (e.g., office occupancy densities for both contract and civil service personnel, and associated full cost accounting for facilities). Automated space allocation optimization is an area where spatial data technologies are being applied to increase overall efficiency and effectiveness. Other information can be extracted from the available data on a case-by-case basis.

Requirements specific to this work area include:

- Provide integrated support of the GIS systems
- Update and enhance GIS databases
- Provide field observation, network solution, equipment readiness, and report generation in support of GPS data gathering and use. Proficiency in use and application of high accuracy GPS equipment, and 3D laser scanning systems is required.
- Develop and enhance software products for the display, maintenance, and publication of building spatial data and Master Plan related data.
- Develop new software tools and maintain existing tools to support the activities of the GIS using .NET and ArcGIS Server technologies.

6.11. Computational Analysis and Programming Services for Research and Flight Projects

This activity includes the mathematical modeling of physical systems; development of real-time embedded systems; 3D graphical scene generation; the determination of com-

putational techniques and algorithms for the solution of the resulting mathematical problems on appropriate computer systems; and the development or adaptation of computer codes to implement the solution process. Mission software may be required for LaRC programs and projects such as the Aviation System Capacity Program, the Clouds and the Earth's Radiant Energy System (CERES) Project, the Airspace Systems Program, and the Aviation Safety Program. Requirements specific to this work area include:

- Establish data management systems, graphical interfaces, and software for combining computer programs to provide for integrated analyses of multidisciplinary research projects.
- Develop embedded flight software systems to provide real-time instrument control and data acquisition.
- Develop ground computer software systems to support instrument development, test, calibration, commanding, and simulation.
- Develop, test, and maintain ground computer software systems that enable flight deck-based, airspace and Air Traffic Management (ATM) simulation systems and research.
- Develop software procedures for the integration and test of a flight experiment with its spacecraft or airframe platform. On-site diagnostic support for comprehensive performance tests that involve the operational behavior of the flight experiment and its attendant flight software and ground systems.
- Write and maintain project documentation for software systems. Programming languages required include, but are not limited, to FORTRAN, C, C++, Java, JavaScript, and Perl.

6.12. Central Computer Facility Environmental Monitoring

The 1268 building complex is comprised of numerous heating, ventilation, air conditioning, mechanical, and electrical systems that are essential to supporting a wide variety of research and Information Technology functions for LaRC. Due to the complexity and potential failure of these systems it is essential that continual monitoring and control of the facility be provided. Also, as result of additions, changes, or deletions to the facility systems and changes in office and equipment areas, there is a frequent need for maintaining current facility drawing and configuration files. Requirements specific to this area include:

- Provide system administration support for all systems required to monitor and control the 1268 building complex HVAC systems.
- Monitor and Maintain 1268 Facility and all LaRC communication closet UPS (Uninterruptible Power Supply) systems.
- Provide facility configuration and layout documentation and drawings
- Provide system administration support to ascertain that the 1268 building complex is in compliance with LaRC Center and Federal electronic and physical security plans.
- Coordinate electrical and mechanical work with respect to site preparation for new and reconfigured computer equipment/facilities.

- Review, monitor, and analyze problems associated with facility power distribution, control systems, HVAC, computer chilled-water systems, and initiate corrective action, including third party hardware and/or software maintenance contracts.
- Monitor and maintain emergency backup power systems (Uninterruptable Power Supplies and Generators) for readiness and maintain operational log book of the power distribution.

Aperture CAD software is used for facility drawings, Siemens Insight HVAC software is used for environmental control, and APC Infrastructure Management System and MGE Monitor Pack software is used for UPS monitoring. Both hardware and software elements are associated with these systems to insure proper and reliable operations.

6.13. Administrative Business Applications/Support

Provide support to the LaRC Office of the Chief Financial Officer (OCFO) in the following areas:

- Evaluate and provide support for management of financial management policies, processes, and controls at the Center, and provide recommendations.
- Provide business systems application development and operational support, including testing, training, and help-desk support.
- Support Center and Agency with system architecture design, development, implementation, and management. This includes compliance with Agency standards and guidance and supporting system architecture relative to documentation, governance, and technical (e.g., database design and user access) components.
- Provide project management and implementation support for business computing projects (Agency or Center). Develop and provide a project scope, work breakdown structure, requirements collection and management, stakeholder identification and analysis, project task planning and scheduling, resource identification and management, risk management support, earned value management, configuration management, business readiness (formerly change management), and related administrative tasks.
- Provide primary or back-up roles identified in LaRC's Operations Level Agreements with the NASA Enterprise Applications Competency Center (NEACC) to ensure that Agency applications are supported at the Center level. These roles include:
 - Provide technical support of the IEM modules that are in production.
 - Provide Center Business Process lead (CBPL) support with liaison responsibility to the NEACC. Responsibilities include supporting year-end and start-up activities, assisting the NEACC and users in troubleshooting problems, and administering WebTADS, NASA Structure Management (NSM), and Metadata Manager (MdM).
 - Provide information delivery (report) support. Provide process knowledge to support end-users with existing reports, as well as, design and develop additional reports or queries as requested.

- Support the monthly cost assessment process by executing process steps in SAP.
- Design, develop, and revise training materials for systems and applications. Schedule classes, arrange logistics for classes, conduct training, validate training effectiveness, track and report training metrics, and provide information for input to student records.
- Create, advise on, or maintain processes that contribute to and monitor the health of financial information and the underlying financial systems.
- Ensure data quality is maintained throughout the key business systems and applications.
- Provide product maintenance, technical support, and customer support to each of the OCFO websites and applications. As part of the standard maintenance service, the contractor shall proactively monitor the applications/sites for service interruptions and functional anomalies.
- Serve as the primary and backup LaRC OCFO LIFE Website Manager.
- Provide support for Retired Systems such as Time and Distribution System (TADS), Electronic Purchase Request System (EPRS), Financial Management System (FMS, Financial Core, Fixed Assets, Job Order, and Invoice Payment), and Labor Distribution System (Manpower).

6.14. Airspace and Traffic Operations Simulation (ATOS) Development and Enhancements

The objective of this task is to develop and enhance NASA-Langley Research Center's (NASA-LaRC) Airspace and Traffic Operations Simulation, including methodologies to enable research experiments in support of future air transportation system concepts and technologies such as those currently being explored by NASA's Airspace Systems Program projects (NextGen Airspace and NextGen Airportal). Tasks will explore new methodologies for the development and enhancement of distributed airborne simulation tools, design and develop new engineering models of revolutionary and enabling airborne technologies, integrate these new simulation tools and engineering models into the ATOS, and aid in the conduct of simulations (including experiment design, data analysis, and reporting) in the Air Traffic Operations Lab (ATOL). The overarching goal is to produce and maintain an integrated, operational, and productive Air Traffic Management (ATM) research tool that also incorporates capabilities for transitioning to simulations of airport surface operations.

Numerous research goals will be met through studies and experiments conducted using the ATOS (hosted in the Air Traffic Operations Lab, or ATOL, at LaRC) as well as with other simulation tools that may be linked to the ATOS for specific experiments. These research goals, many of which require new capabilities, include (but are not limited to) the following: (1) evaluating the impact of uncertainties, real-world system behaviors, weather, and human factors on the safety and performance of airborne trajectory management applications; (2) developing new 4D dynamic Required Navigation Performance (RNP) capabilities and determining how they may affect the performance of various airborne applications integrated with ground-based operations; (3) creating new metrics for dynamic airspace complexity and evaluating the effects of various distributed

complexity-mitigation functions and en-route coordination strategies; and (4) evaluating different algorithms and procedures for super-density terminal area merging and spacing applications. In the area of airport surface operations, research goals include: (1) evaluating Collision Avoidance for Airport Traffic (CAAT) algorithms in the low altitude, runway, and taxiway operating environment; (2) evaluating integrated aircraft-based CAAT and ground-based taxi conformance monitoring and longer term collision detection and resolutions solutions; and (3) developing and evaluating algorithms and procedures to maximize airport arrival and departure capacity, including reduced in-trail separation requirements, closely-spaced and converging/intersecting runway operations, and runway balancing.

Development, implementation, and integration of new simulation capabilities will be required to perform vital studies and experiments in support of planned research goals. These simulation capabilities generally fall into the following categories: (1) development of engineering models of advanced technologies that enable new concepts of operation, such as airborne four-dimensional (4D) trajectory & separation management, conflict detection and resolution (particularly with regards to loss of separation), terminal area merging and spacing, and in-trail procedures (oceanic and domestic) for enroute climbs and descents; (2) new 4D trajectory generation capability for the on-board flight management computer (FMC), including a common lexicon for the exchange of 4D trajectory data between various airborne and ground-based systems and applications; (3) advancements in the simulation of the basic aircraft, including airframe and engine performance models and control laws; (4) improvements to fundamental simulation control functions, including timing, mode transitions, and scenarios, that support the full range of experiment types from real-time human-in-the-loop studies to large-scale batch runs; and (5) evaluation of algorithms and procedures for airport arrival and departure operations.

A major aspect of ATOS enhancement is the continued development, implementation and integration of an enhanced onboard automation system that supports flight-crew decision-making for airborne trajectory and separation management. This capability is used to conduct simulation-based research of advanced ATM concepts that involve distributed responsibility for ATM functions such as traffic separation, airspace hazard avoidance, trajectory constraint meeting, and airspace complexity management. This capability is intended to allow studies of multi-aircraft interactions in a distributed-control architecture. Of particular interest is the safety of distributed control under the wide variety of conflict geometries and causal factors that can arise. To support a quantitative analysis of safety, functions must be made sufficiently robust for testing in batch mode over many thousands of runs and under a wide variety of scenarios and test conditions. Also of interest are new functions considered for distribution, such as trajectory flexibility preservation and constraint minimization, which must be integrated with other functions and tested for feasibility. Such functions will allow studies of distributed management of traffic complexity, a proactive approach to reducing safety risk in multi-aircraft scenarios.

Requirements specific to this work area include:

- Develop, test, and integrate new software capabilities, as well as software modifications, within and across ATOS subsystems, required to meet simulation capability and experiment needs for ongoing research;

- Perform configuration management tasks to maintain the ATOS software base-line;
- Integrate ATOS software with production hardware in the ATOL;
- Perform regression testing of ATOS software development builds;
- Provide enhancements to adapt to evolving research requirements;
- Determine best experimental methodologies for posed research questions;
- Develop enabling technology (engineering) models of advanced airborne technologies supporting trajectory planning and guidance;
- Determine appropriate level of modeling fidelity for each aspect of the ATOS' component subsystems, including but not limited to aircraft performance, CNS (Communication., Navigation and Surveillance) infrastructure, and the operating environment (including air traffic and airport surface scenarios);
- Support the exploration of large-scale effects of multi-aircraft interactions in the proposed NextGen concepts of operation, especially between aircraft of significantly different performance characteristics;
- Develop advanced traffic generation capabilities that include real-time background target generation for ATOS scenarios, fast-time stand-alone simulation capability for batch studies, tools for scenario design and prototyping, and data recording;
- Model typical pilot behaviors while interacting with new ATM research tools;
- Improve connectivity with other simulation tools and facilities;
- Provide functional description documentation for all software components;
- Document operating instructions.